Technical Support for Permit Modification Application

Calciners A & B Fuel Switch OP 30-126

SOLVAY SODA ASH JV

PROJECT NO. 170-4
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List of Abbreviations

ACFM	Actual Cubic Feet per Minute
BACT	Best Available Control Technology
BLM	Bureau of Land Management
BPIP	Building Profile Input Program
CD	Compact Disk
CO	Carbon Monoxide
DEM	Digital Elevation Model
DEQ	Wyoming Department of Environmental Quality
EIS	Environmental Impact Study
EPA	The United States Environmental Protection Agency
ESP	Electrostatic Precipitator
FLAG	Federal Land Managers Air Quality Related Values Workgroup
ISCST	Industrial Source Complex Short Term
MMBtu	Million British Thermal Units
NAAQS	National Ambient Air Quality Standards
NESHAP	National Emission Standards for Hazardous Air Pollutants
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
NSPS	New Source Performance Standards
NWS	National Weather Service
PM_{10}	Particulate Matter (with aerodynamic diameter = 10 micron)
PSD	Prevention of Significant Deterioration
PTE	Potential to Emit
SIL	Significance Impact Level
SO_2	Sulfur Dioxide
Tpy	Ton per Year
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
VOC	Volatile Organic Compound
WAAQS	Wyoming Ambient Air Quality Standards

SECTION 1

INTRODUCTION

Solvay Soda Ash JV (Solvay) proposes to modify two of its calciner furnace combustion systems (Calciners A and B) to be fired on coal instead of natural gas, the current fuel. With this furnace fuel switch there will be a significant (present actual to proposed potential) increase in nitrogen oxides (NO_x), carbon monoxide (CO), volatile organic compounds (VOC), and particulate matter (PM_{10}) emissions, which trigger a PSD source modification review. This technical support report provides the review of the various requirements triggered by PSD rules. This report also contains a facility description (Section 2), followed by a regulatory applicability review (Section 3), a control technology review (Section 4), and impact reviews, both for Class II and Class I areas (Sections 5 and 6), and a compliance demonstration plan (Section 7).

The Solvay facility is located in Section 31, T18N, R109W in Sweetwater County, Wyoming. The UTM (Universal Transverse Mercator) location is Zone 12, 603.3 km Easting and 459.4 km Northing; and the geographic coordinates are 41.49 degrees latitude and 109.76 degrees longitude. The facility location on a regional scale map is shown in Figure 1.1, and the west view of the facility and the combined stack for Calciners A and B is shown on Figure 1.2.

Figure 1.1: Solvay Facility Location on a Regional Scale Map

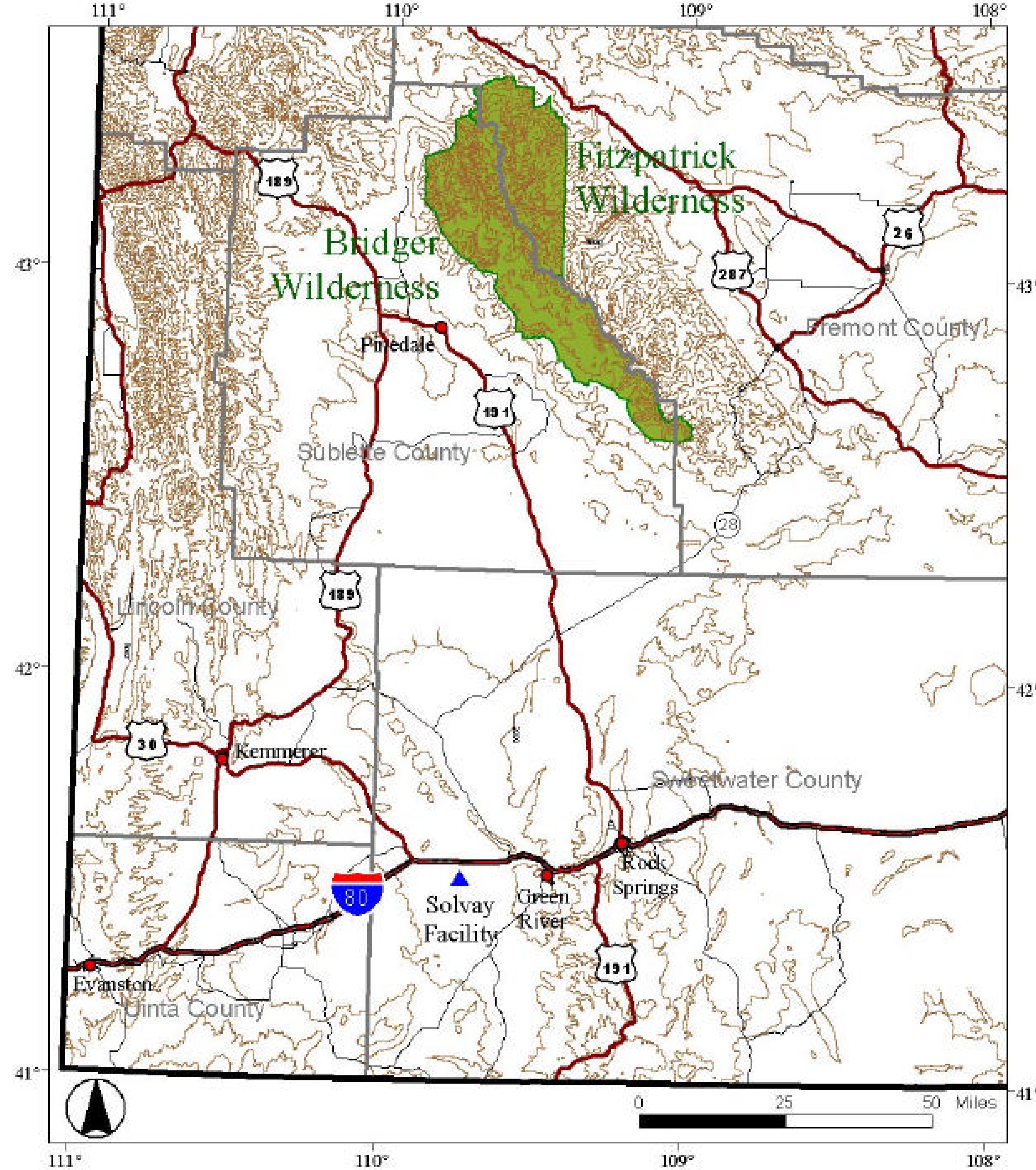

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Figure 1.2: West View of Solvay Facility

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SECTION 2.0

FACILITY DESCRIPTION

The Solvay facility is an existing underground trona mine with surface processing facilities. The trona ore (sodium sesquicarbonate dihydrate [Na_2CO_3?$NaHCO_3$?2H_2O]) is processed into sodium-based products, including soda ash (sodium carbonate [Na_2CO_3]). Construction of the facility began in 1979, and it became operational in 1982. Its sources consist principally of calciners, dryers, boilers, and material handling processes. The facility is presently permitted under Operating Permit No. 30-126 and has a potential to emit 405 tpy of particulate matter (PM_{10}); 619 tpy of sulfur dioxide (SO_2); 2,440 tpy of nitrogen oxides (NO_x); 2,464 tpy of volatile organic compounds (VOC); and 7,431 tpy of carbon monoxide (CO). There are four gas-fired calciners, two gas-fired dryers, two coal-fired boilers, and other smaller gas-fired combustion units. This application addresses a proposed change in the heat-generating furnaces associated with the calciners, which are used to convert the trona ore to a crude soda ash by driving off the CO_2 and H_2O.

Solvay is proposing to convert the furnaces associated with Calciners A and B (Source #17) from natural gas-firing to coal-firing. These calciners are vented to a common stack with the stack parameters provided in Table 2.1. There will be a new calciner coal bunker for coal handling, and any handling emissions will consist of particulates, which will be vented through a small new baghouse. This source was deleted in the 1995 conversion from coal- to gas-firing (MD-229), but will be refurbished and repermitted for this project. The stack parameters for this new source (Source #100) are provided in Table 2.2. From Table 2.1 it is apparent that with the shift to coal-firing, Source #17 will experience a 20-percent reduction in heat rate, but an increase in airflow, resulting in a substantial increase in airflow per unit of heat. The other stack parameters will remain the same. Potentials to emit and 2000/2001 actual emissions are shown in Table 2.3. The plant layout with the various buildings and all the facility emission points is shown on Figure 2.1, with Sources #17 and #100 specified.

With an increase in coal consumption related to Source #17, there could be an increase in the number of hours of baghouse operation and, therefore, an increase in actual emissions from Sources #10 and #11, coal crushing, storage, and transfer. These two sources had actual PM_{10} emissions of 0.18 and 0.15 tpy as an average for 2000 and 2001. Actual emissions will remain at or below the presently permitted PTEs of 1.14 and 0.92 tpy respectively. Since these emission units are not being modified, their actual emission increases are not further addressed.

Table 2.1: Modified Source #17 Physical Stack Parameters

Description	Present	Proposed
Height	180.5 ft	Unchanged
Heat Rate	500 MMBtu/hr	400 MMBtu/hr
Exit Diameter	12 ft	Unchanged
Exhaust Velocity	44 ft/sec	96 ft/sec
Exhaust Temperature	375°F	400°F
Flow Rate	312,000 ACFM	650,000 ACFM
Location	603,686 m (East)	Unchanged
	4,594,808 m (North)	Unchanged

Table 2.2: New Source #100 Physical Stack Parameters

Description	Proposed
Height	126 ft
Exit Diameter	1 ft
Exhaust Velocity	64 ft/sec
Exhaust Temperature	Ambient (68°F)
Flow Rate	3,000 ACFM
Location	603,681 m (East)
	4,594,817 m (North)

Table 2.3: Sources #17 and #100 Emission Rates in Tons per Year (tpy)

Column #1	Column #2	Column #3	Column #4	Column #5	Column #6	Column #7	Column #8
Pollutant	Source #	Present Actual Emissions*	Present Potential to Emit	Proposed Potential to Emit	PSD Review Threshold	Increase From Actual to Proposed PTE	PSD Review Triggered?
NO_x	17	49	131	788	40	739	yes
CO	17	1,077	6,675	5,533	100	4,456	yes
PM_{10}	17	32	98	180	15	148	
	100	0	0	1	15	1	yes
VOC (as ozone precursor)	17	1,199	3,399	2,714	40	1,515	yes

* Average of years 2000 and 2001.

Figure 2.1: Solvay Facility Plant Layout and Emission Points

The 2000 and 2001 averaged actual emission rates and permitted potential to emit (PTE) for Source #17 are provided in Columns 3 and 4 of Table 2.3. The proposed PTEs under coal-firing of Sources #17 and #100 are listed in Column 5. For purposes of determining the triggering of "Major Modification" (Wyoming Air Regulations, Chapter 6, Section 4(a)(xii)), the "net emissions increase" is to be calculated, which is the difference between the proposed PTE and the present actual emissions. The review threshold amounts are listed in Column 6. The net emissions increase is provided in Column 7. From these increases it is apparent that NO_x, CO, PM_{10}, and VOC emissions are to be reviewed by the Major Modification review procedures.

Comparing present PTE (Column 4) with proposed PTE (Column 5), the increased NO_x emissions are due to an increase in the emission factor (mass of NO_x per unit of heat) of the coal burner. Although there will be sulfur in the coal, the trona ore will effectively absorb all of it during the calcination process, which was previously demonstrated by stack tests when Source #17 was originally fired on stoker coal. (Note that trona and soda ash are commonly used as SO_2 scrubbing agents.) There will be a minor increase in the coal burner's CO emission factor, offset by the decrease in trona feed rate and the CO emissions inherent in the trona calcination process, resulting in the proposed PTE being less than the present PTE. There will be no change in the VOC emission factor, which is almost entirely a function of the trona feed rate (mass of VOC per unit of trona feed), but there will be a decrease in the VOC emissions because of a decrease in the trona feed rate, resulting in the proposed PTE being less than the present PTE. There will be no increase in the PM_{10} emission factor (mass of PM_{10} per unit of airflow through the electrostatic precipitator). However, since there will be an increase in airflow, there will be an increase in the mass of potential PM_{10} emissions.

SECTION 3

AREA DESIGNATION AND APPLICABLE REQUIREMENTS

Southwest Wyoming is designated as attainment for all WAAQS pollutants, so this facility modification will only address the attainment regulations. The permitting process is described in "Wyoming Air Quality Standards and Regulations," Chapter 6. Section 4 describes the Major Emitting Facility review procedures. In addition to the permitting requirements, the New Source Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAP) requirements of Chapter 5 are applicable. The applicable requirements are:

Chapter 5, Section 2: There is no applicable NSPS for Source #17. Subpart UUU addresses "Calciners and Dryers in the Mineral Industries," but soda ash is not included within the definition of such an industry, Subpart 60.731).

Chapter 5, Section 3 (NESHAPs): Source #17 is not in a listed source category. Therefore, this section is not applicable.

Chapter 6, Section 2, a, I: Solvay plans to modify an existing facility, which may cause the issuance of an increase in air contaminants. Thus, Solvay must file a permit application. Solvay is subject to Chapter 6, Section 3 (Major Source Operating Permits), and will submit a separate application for that purpose at a later date, within 12 months after the Source #17 conversion.

Chapter 6, Section 2, b, i: The application is to include plans and specifications, and the manner in which the sources are to be operated and controlled. The application is also to include a construction schedule.

Chapter 6, Section 2, b, i: Baseline ambient monitoring may be required, at the discretion of the Administrator. This proposed modification may result in a potential increase in NO_x, PM, and CO emissions. There will also be a present actual to future potential increase for VOCs. Solvay believes that adequate representative regional NO_x and ozone data from Seedskadee exist. Representative CO data exists from earlier monitoring, and the present on-site PM_{10} monitoring will be sufficient to define a representative baseline for this application.

Chapter 6, Section 2, c, ii: The application must demonstrate compliance with the WAAQS, as shown in Section 5.

Chapter 6, Section 2, c, iii: The application must demonstrate compliance with PSD increments, as shown in Section 5.

Chapter 6, Section 2, c, v: The sources must utilize best available control technology (BACT). A BACT analysis is found in Section 4 .

Chapter 6, Section 2, c, vi: The facility must have adequate provisions for measuring the significant emissions. These are already in place for the present configuration of Source #17, as described in the current OP30 - 126. The significant increase in NO_x will trigger the 40CFR64 CAM monitoring requirements.

For purposes of determining the triggering of "Major Modification" (Chapter 6, Section 4, a, x) permit review requirements, the Wyoming regulations (Subsection xii) require a calculation of the "net emissions increase" which is the difference between the proposed PTE and the present actual emissions. The net emissions increase is provided in Column 7of Table 2.3, and from this it is apparent that NO_x, CO, PM, and VOC emissions are to be reviewed by the Major Modification or Chapter 6, Section 4, review procedures.

Chapter 6, Section 5: Not applicable because there are no MACT standards for this source.

Chapter 6, Section 6, h (112 [g] MACT for Constructed and Reconstructed Major Sources): Source #17 is not being constructed or reconstructed (h, i, "Applicability") because the new burner in and of itself will not be emitting HAP emissions greater than 10/25 tpy (by f, xii, definition of "reconstruction") .

Chapter 6, Section 6, h (112[j] case-by-case MACT): Source #17 is not a listed source within the October 16, 2002, updated list of proposed MACT Source Categories.

SECTION 4

PROPOSED CONTROLS - BACT

The potential emissions from coal combustion in Source #17 is presented in Table 2.3, Column 4 and the calculation is presented in Appendix A. There will be significant increases in the NO_x, CO, PM_{10}, and VOC emissions, which triggers the need for a formal Best Available Control Technology (BACT) review for these four pollutants. The remainder of this section is a BACT analysis.

Solvay proposes to modify the furnaces that provide hot air to calciners A and B (Source #17). Solvay is not modifying the calciners, and this BACT only addresses the furnaces with their associated revised emissions. These are essentially industrial furnaces, each to be fueled by coal at a rate of 200 MMBTU/hr, with an exhaust temperature of 1,800°F, and airflow of 5,300 lb/minute. With regard to the combustion kinetics and NO_x formation, these furnaces are different from boilers, which contain heater tubes that extract heat as the combustion air flows down the boiler where the combustion can be staged. These furnaces are not like cement/lime kilns or diatomaceous earth calciners where the combustion takes place within the calciner. Nor are they similar to kaolin kilns where the combustion is also within the kiln. They are industrial furnaces.

The BACT process is described in the "Puzzle Book" (New Source Review Workshop Manual, Draft, October 1990, U. S. EPA, Chapter B). The process consists of five distinct steps for the purpose of determining the "…the maximum degree of reduction … which would be emitted… which the Administrator, on a case by case basis, taking into account energy, environmental and economic impacts, and other costs, determines is achievable for such source…". These five steps are:

- Identify all available control technologies.
- Eliminate technically infeasible options.
- Rank remaining options by control effectiveness.
- Evaluate control effectiveness from top down.
- Select BACT.

4.1 BACT Review - NO_x Emissions

The BACT review process described above is applied to the NO_x emission controls for the Solvay industrial furnaces in this subsection.

4.1.1 Identify all Available NO_x Combustion Control Technologies

There is no discussion of combustion emissions and controls for the trona industry in AP-42 Section 8.12, which addresses the Sodium Carbonate industry. The section refers to Chapter 11, industrial facilities, for more specific emissions information. In fact, AP-42, Chapter 1, Section 1, "bituminous and sub-bituminous coal combustion," comes closest of all AP42 sections to address the NO_x control methods available to Solvay for these furnaces; although, this section is directed almost entirely to boilers. The list of NO_x control options from this section is given below. Section 11.17, Lime Manufacturing, Section 11.3, Brick Manufacturing, and Section 11.6, Portland cement manufacturing, also discuss NO_x controls and add the "preheater" as an option to those listed in Chapter 1, Section 1. The range of the NO_x control options derived from these AP-42 sections is as follows:

- Operational Modifications (rearrangement of air and fuel for good engineering design [GED])
- Over-Fire Air (OFA)
- Low-NO_x Burners (LNB)
- Reburn
- Selective Non-Catalytic Reduction (SNCR)
- Selective Catalytic Reduction (SCR)
- Preheaters

Solvay's engineers add the following two possible control technologies:

- Flue Gas Recirculation (FGR)
- Water Injection (WI)

A search of the RACT BACT LAER Clearinghouse for other possible NO_x control technologies applied to coal-fueled devices other than boilers (e.g., furnaces, incinerators, kilns, dryers) yields the information in Table 4.1.

Table 4.1: Installed NO_x Control Technologies Listed in the RBLC for Coal-Fueled Devices Other Than Boilers

Control Technology	Number of Cases in the Clearinghouse
No control	15
Careful combustion control	18
Low-NO_x combustors	9
Urea spray into preheater combustion zone – SNCR	2
Conversion to add a pre-calciner (preheater)	3
Steam injection, alkaline stream in venturi scrubber	1
Kiln afterburner	1
Wet scrubbers	2
Baghouse	2

The California ARB Control Technology database contributed two additional sources. The two California determinations were both for cement plants, and both employed pre-calciners and good combustion practices.

From these tables wet scrubbers, baghouses, and steam injection into the venturi scrubber are discounted as controls for particulates, and it is concluded that there are no additional feasible NO_x technologies to add to the AP42 and Solvay Engineers list.

4.1.2 Eliminate Technologically Infeasible Technologies

There are two fundamentally different types of coal-fueled furnaces that could satisfy the Solvay calciner needs, pulverized coal (PC) or stoker coal (SC) furnaces. Both are limited in size by the volume available in front of the calciner and limited in slagging characteristics to a buildup rate that will not substantially disrupt operations. The location restriction is forced by the need to be near the calciner host to maintain a high air temperature to the host, and to be near the flue gas for NO_x control purposes (as explained in this section).

Regardless of the furnace type, SCR is infeasible because the temperatures of the exhaust gases at the exit of the particulate control system are about 350°F, which is well below the 700°F minimum temperature needed for the SCR reaction.

AP-42 (page 1.1-9) also rules out low-NO_x burners (LNB) for furnaces in the following statement. This is because a furnace, unlike a boiler, has no heat extraction as gases pass down the furnace:

> *LNBs are applicable to tangential and wall-fired boilers of various sizes but are not applicable to other boiler types such as cyclone furnaces or stokers.*

Preheaters are devices unique to cement and lime kilns. There is insufficient waste heat in the Solvay calciner circuit to provide pre-heating to the pulverized feedstock. Thus preheaters are technologically infeasible.

Reburn is a control technology that requires injection of natural gas downstream of the coal combustion and is applicable only in very specific boiler configurations, different from the Solvay furnaces. For Solvay's application it is technologically infeasible.

The remaining NO_x control possibilities are GED, OFA, SNCR, FGR, and WI as possibly being technologically feasible.

Solvay retained an expert coal combustion specialty firm (Reaction Engineering, Salt Lake City) to assist in the design and selection of the furnace technologies. Reaction Engineering requested bids for the two alternatives furnace types, PC and SC, with emphasis on the need for low-NO_x emissions and the results are as follows.

PC Furnace Design

The combustion engineering consultant performed a survey of the market for current designs that could meet the various production, low-NO_x emission, and space limitation criteria. The results from the search for the PC-fired designs are attached in Appendix B. The conclusion is that most manufacturers do not have, nor are interested in developing a furnace for Solvay's needs that would have NO_x emissions lower than about 1.5 lb/MMBtu, which is well above the original Solvay furnace emission factor of 0.75 lb/MMBtu.

One manufacturer offered a theoretical design (listed under Black & Veatch) that could meet 0.35 lb/MMBtu under the special requirements of an additional gas-fired inlet air duct heater and micronized coal injection, both of which are relatively untested in general, and not tested for Solvay's specific requirements. Moreover, this special furnace would require a substantial use of natural gas in addition to the coal for proper operation. This special furnace would be considered, at best, as available through technology transfer. However, it has not been shown in any full-scale operation to provide the required service to the host calciner. In other words, there is no demonstration that it can actually do the job reliably (operation without system breakdowns and unacceptable slag buildup, shown to occur in previous PC furnace testing for Solvay) for which it is being considered. Thus, in line with the EPA guidance Puzzle Book, Chapter B, IV, A, 1, "technologies which have not yet been applied to full-scale operations need not be considered available; an applicant should be able to purchase or construct a process that has already been demonstrated in practice." Solvay considers this special design as a not "commercially available" process unit.

SC Furnace Design

Detroit Stoker Company provided the only bid for an SC furnace with low-NO_x emissions. In their design they experimented with four of the remaining process modifications for NO_x control not eliminated yet as technologically feasible control technologies, incorporating GED and OFA in all designs. The results of the combustion modeling with these control options are shown in Table 4.2. There were multiple operational considerations being tracked along with NO_x emissions, only two of which are also shown in Table 4.2 (carbon in fly ash and percentage of fly ash exiting through the grate). Both WI and FGR provided control, but their effects do not combine for certain engineering reasons. FGR provides better NO_x control than WI, so the combination of GED, OFA, and FGR are selected by Detriot Stoker as their lowest-emission design to guarantee a NO_x emission rate of 0.45 lb/MMBtu.

Table 4.2: NO_x Emissions for Various Combinations of Controls Built Into the Furnace Design

	Past Config. (1980)	OFA Config.	Water Inj. + OFA Config.	FGR + OFA Config.
Exit CO (ppm)	34	25	22	522
Exit NO_x (lb/MMBtu)	0.70	0.79	0.50	0.42
(ppm)	278	308	194	161
C in Fly Ash	60 %	58 %	74 %	73 %
% Exiting as Grate Ash	73 %	87 %	86 %	72 %

SNCR is an add-on control technology that, to the knowledge of Reaction Engineering and Detroit Stoker, has not been applied to SC furnaces, and any application would require further research and testing. Therefore, Solvay considers SNCR to be not commercially available.

Although the Solvay furnaces are unlike other coal-fueled source categories, a statistical summary of the NO_x emission factors for all facilities other than boilers from the RACT BACT LAER Clearinghouse (RBLC, 1993 - 2002) is provided in Table 4.3 for comparison. To generate Table 4.3, an assumption was made for some of the lime and cement kilns that an average thermal efficiency of 5.5 MMBtu heat input was required per ton of product in order to convert all emissions to the units of mass NO_x per MMBtu heat input. From this Table 4.3 comparison it is apparent that the proposed Solvay furnace NO_x emissions are below the average for all categories and near the minimums.

Table 4.3: Pounds of NO_x per MMBtu From Coal-Fueled Devices Other Than Boilers

Process	Count	Average	Min.	Max.	Range
Cement	10	1.26	0.43	3.40	2.97
Lime	6	0.53	0.37	0.64	0.27
Coal dryer	5	0.55	0.43	0.80	0.37
Refractory	2	6.55	6.18	6.91	0.73

4.1.3 Selection of BACT for NO_x

Solvay asserts that a feasible technology with the lowest NO_x emissions for the calciner furnaces is the Detroit Stoker design at 0.45 lb/MMBtu. Since Solvay is committing to the installation of this technology, it represents BACT for NO_x emissions.

4.2 BACT Review - PM Emissions

Source #17 presently has electrostatic precipitators (ESP) installed as the particulate control. These are considered to have a control efficiency of over 99 percent for fly ash (AP42, Table 1.1-9). Although baghouses are more efficient, the difference of about one half percent would result in a potential to emit difference of less than 50 tons of PM_{10}. Solvay asserts that the cost for conversion from ESP to baghouse to gain a 50 ton per year reduction would exceed a reasonable cost, without performing the calculation. Therefore, Solvay asserts that BACT for particulates is the presently installed ESPs.

4.3 BACT Review - VOC and CO Emissions

A BACT analysis was prepared for VOC and CO emissions in the CT - 1347 (February 6, 1998) permit application. The cost data provided in this analysis is still current. Since the air flow rates will be increased per unit of throughput, these costs will increase for the scenario of stoker coal combustion. Thus that analysis is sufficient for the VOC BACT analysis. There will be no VOC control, and the CO control will consist of good combustion control with the maintenance procedures described in Appendix B of OP30 - 126.

SECTION 5

ENVIRONMENTAL EVALUATION - CLASS II AREAS

The proposed furnace conversion is associated with a significant increase in NO_x, CO, PM_{10}, and VOC emissions. As required by the Wyoming permitting rules, the impacts of these four pollutants are estimated for the areas surrounding the facility, which are Class II areas. The first three pollutant impacts are estimated using the ISCST3 dispersion model and five years (1987 to 1991) of Rock Springs meteorological data. The O_3 impacts, expressed in terms of VOC and NO_x emissions, are estimated using Scheffe's screening tables. The methodology for these analyses is based on the modeling protocol (dated December 2002) and on the subsequent response to the Wyoming DEQ questions (dated February 3, 2003). The Wyoming DEQ requested a full PM_{10} increment consumption analysis with previous permit applications; therefore, although not required, the full analysis is again conducted. A screening risk assessment addressing the impacts of the HAPs from coal firing is also included and is based on the above long-term ISCST3 emission to impact ratios. Each of these analyses is discussed briefly in the following sections.

5.1 Dispersion Modeling for NO_x, PM_{10}, and CO

The preliminary step in the impact analysis is to determine for each pollutant whether the impacts from the net emission increases from the project (Table 2.3, Column 7) are less than the applicable Significant Impact Levels (SILs). If the impacts are less than the SILs, then no actual impact analysis is required. However, if the impacts are significant, then a full analysis is needed.

The results of this preliminary analysis are summarized in Table 5.1. The source locations, the property boundary, and the locations of the maximum impacts (from Table 5.1) are presented in Figure 5.1. This figure shows that all of the maximum impacts occur on or near the property boundary line, and Table 5.1 shows that the impacts of the three pollutants are below their respective SILs for all averaging periods. Thus, no further Class II impact analyses are required for these pollutants.

Table 5.1: Estimated Maximum Impacts Compared With SILs

Pollutant	Averaging Period	Maximum Impact ($\mu g/m^3$)	Location Easting (m)	Location Northing (m)	Year	SIL ($\mu g/m^3$)
NO_x	Annual	0.6	604,400	4,594,900	1988	1.0
PM_{10}	Annual	0.2	604,400	4,594,900	1988	1.0
	24-Hour	2.8	603,000	4,594,000	1991	5.0
CO	8-Hour	161.0	603,000	4,594,000	1991	500.0
	1-Hour	363.7	602,600	4,593,700	1989	2,000.0

The ISCST3 and BPIP model input and output files, meteorological data files, DEM files, and other related documentation are provided on the attached compact disk.

5.2 O_3 Evaluation

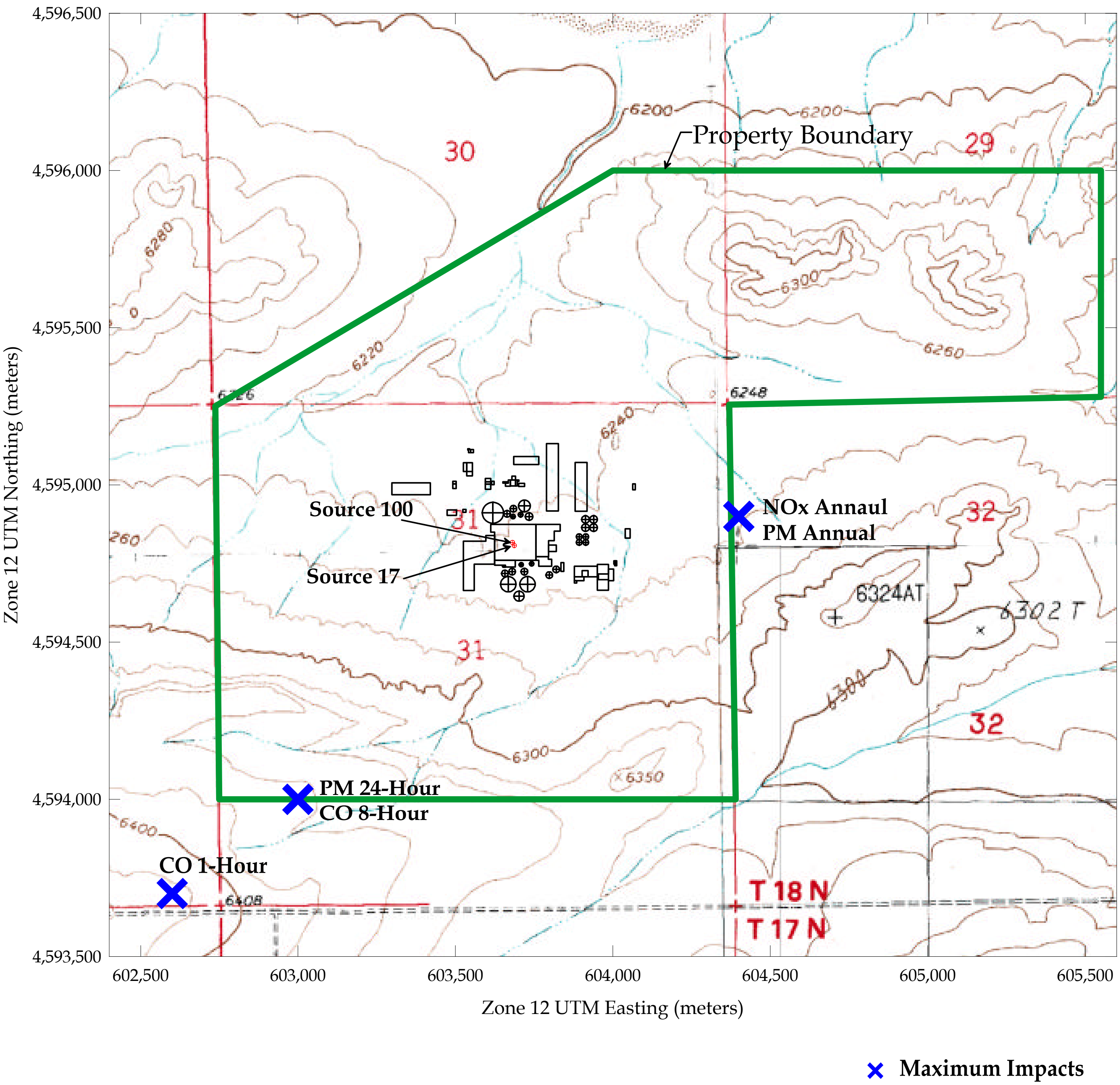
There is no SIL for O_3, so the O_3 impacts are estimated and compared with the applicable WAAQS. The O_3 impact analysis uses Scheffe's screening tables (VOC/NO_x Point Source Screening Tables, 1988). The procedure and calculations for O_3 estimation and applicable rural screening table are presented in Appendix C on Sheets C.1 and C.2. The maximum predicted O_3 concentration from Scheffe's screening table, the O_3 background concentration, and the applicable Wyoming O_3 standard are shown in Table 5.2.

Table 5.2: Estimated O_3 Concentration Compared With WAAQS

Averaging Period	Estimated Concentration (μg/m³)	Background Concentration (μg/m³)	Maximum Predicted Concentration (μg/m³)	WAAQS (μg/m³)
1-hour	66.1	161.0	227.1	235

Table 5.2 shows that the maximum predicted O_3 impact from Solvay's VOC emissions is expected to be below the O_3 WAAQS.

Figure 5.1: Maximum Impacts from Proposed Emission Increases from Source # 17 and # 100



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5.3 Full PM_{10} PSD Increment Consumption Analysis

Although not required by the Wyoming DEQ, Solvay also conducted a PM_{10} increment consumption analysis to demonstrate compliance with the PM_{10} PSD increment standards. The methods were the same, except for the modified PM_{10} emissions as a previously conducted analysis (*Solvay Minerals Inc., Particulate Matter Impact Analysis Trona Products Expansion, April 2002*). This analysis also includes emissions from the two nearby facilities (FMC – Westvaco and General Chemical) as recommended by the Wyoming DEQ for the previous analysis.

The Solvay facility-wide and the nearby increment-consuming sources, their PM_{10} emission rates, and other modeling parameters are listed in Table 5.3. Again, five years (1987 to 1991) of Rock Springs meteorological data were used. The modeling methodology and the assumptions made are the same as in the previous analysis. Further details about the assumptions, the applied methodologies, and data sets used, are provided in the previous report.

The digital modeling files and a copy of the previous analysis report are also provided on the attached compact disk.

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Table 5.3: Modeled Stack Parameters

Emission Point ID	UTM X (m)	UTM Y (m)	Base Elevation (m)	PM_{10} Emission Rate (lb/hr)	PM_{10} Emission Rate (g/s)	Stack Height (ft)	Stack Height (m)	Exit Temperature (^{o}K)	Exit Velocity (m/s)	Exit Diameter (m)
Existing Solvay Minerals Emissions Points										
2A	603677	4594992	1900	1.59	0.20	23	7.01	293	15.85	1.06
6A	603893	4594835	1903	0.32	0.04	133	40.54	309	24.99	0.64
6B	603922	4594848	1903	0.48	0.06	15	4.72	297	10.06	0.67
7	604037	4594848	1906	1.19	0.15	82	24.99	293	19.51	0.75
10	603874	4594983	1900	0.24	0.03	13	4.05	293	5.49	0.60
11	603872	4594811	1901	0.24	0.03	35	10.76	293	6.40	0.55
14	603770	4594807	1902	0.40	0.05	125	38.10	293	17.37	0.43
15	603721	4594807	1902	4.36	0.55	180	54.86	347	14.94	1.83
16	603721	4594816	1902	0.87	0.11	126	38.40	369	12.80	1.07
18	603842	4594804	1902	5.00	0.63	180	54.86	325	17.68	2.21
19	603842	4594792	1902	5.00	0.63	180	54.86	322	18.29	2.21
24	603804	4594780	1902	0.32	0.04	25	7.62	302	12.50	0.30
25	603694	4595017	1900	1.03	0.13	76	23.16	293	14.63	0.73
26	603679	4594992	1900	0.56	0.07	67	20.42	311	17.68	0.73
27	603712	4594998	1900	0.48	0.06	60	18.29	293	18.90	0.48
28	603729	4594829	1902	2.93	0.37	140	42.67	347	12.19	1.22
30	603939	4594757	1902	0.24	0.03	88	26.82	293	17.98	0.20
31	603939	4594747	1902	0.24	0.03	88	26.82	293	17.98	0.20
35	603931	4594712	1905	1.43	0.18	103	31.39	327	14.63	0.70
36	603960	4594712	1905	0.08	0.01	60	18.29	338	25.88	0.15

Table 5.3: Modeled Stack Parameters (continued)

Emission Point ID	UTM X (m)	UTM Y (m)	Base Elevation (m)	PM_{10} Emission Rate (lb/hr)	PM_{10} Emission Rate (g/s)	Stack Height (ft)	Stack Height (m)	Exit Temperature (°K)	Exit Velocity (m/s)	Exit Diameter (m)
37	603967	4594712	1905	0.08	0.01	60	18.29	338	25.88	0.15
38	603974	4594712	1905	0.08	0.01	60	18.29	338	25.88	0.15
44	604005	4594752	1905	0.16	0.02	63	19.20	293	17.07	0.30
45	604030	4594847	1906	0.24	0.03	18	5.43	293	8.84	0.27
46	603765	4595011	1900	0.71	0.09	13	3.81	293	14.02	0.67
48	603687	4594848	1902	9.28	1.17	180	54.86	450	9.75	3.20
50	603725	4594848	1902	0.71	0.09	180	54.86	366	8.23	1.37
51	603752	4594829	1902	2.38	0.30	180	54.86	422	10.06	2.44
52	603901	4594864	1903	0.48	0.06	141	42.98	293	15.24	0.46
53	603901	4594848	1903	0.48	0.06	30	9.14	293	10.97	0.85
54	603694	4594986	1900	0.16	0.02	64	19.57	293	24.08	0.18
62	603657	4594740	1900	0.16	0.02	91	27.74	293	33.53	0.15
63	603652	4594740	1900	0.16	0.02	58	17.68	293	35.66	0.15
64	603981	4594700	1905	0.08	0.01	29	8.84	293	29.26	0.15
65	603962	4594700	1905	0.08	0.01	8	2.44	293	11.58	0.23
66	603701	4594758	1902	0.56	0.07	20	6.10	293	22.86	0.30
67	603634	4594808	1902	0.48	0.06	125	38.10	311	10.06	0.46
68	603933	4594829	1905	0.40	0.05	82	24.99	293	23.47	0.37
70	603933	4594817	1905	0.24	0.03	82	24.99	293	14.94	0.40
71	603928	4594817	1905	0.24	0.03	82	24.99	293	14.94	0.40
72	603910	4594706	1905	0.08	0.01	61	18.49	366	16.15	0.20

Table 5.3: Modeled Stack Parameters (continued)

Emission Point ID	UTM X (m)	UTM Y (m)	Base Elevation (m)	PM_{10} Emission Rate (lb/hr)	PM_{10} Emission Rate (g/s)	Stack Height (ft)	Stack Height (m)	Exit Temperature (°K)	Exit Velocity (m/s)	Exit Diameter (m)
73	603894	4594705	1905	0.87	0.11	95	28.96	305	17.07	0.61
76	603598	4595004	1900	2.46	0.31	110	33.53	293	17.22	1.12
79	603491	4595006	1900	0.87	0.11	68	20.73	293	18.26	0.63
80	603685	4594882	1902	12.21	1.54	180	54.86	425	15.49	3.20
81	603786	4594848	1902	0.48	0.06	120	36.58	394	23.29	0.51
82	603760	4594829	1902	3.41	0.43	180	54.86	421	13.15	2.44
83	603916	4594883	1903	0.40	0.05	130	39.62	366	17.47	0.51
85	603687	4594822	1902	0.48	0.06	140	42.67	436	15.24	0.91
88	604030	4594877	1906	0.24	0.03	11	3.35	293	19.51	0.30
90	603965	4594700	1905	0.08	0.01	23	7.01	293	19.20	0.15
91	603960	4594700	1905	0.08	0.01	24	7.32	293	19.20	0.15
92	603983	4594712	1905	0.32	0.04	64	19.51	293	25.91	0.32
93	603992	4594712	1905	0.16	0.02	70	21.34	293	16.15	0.30
94	603984	4594719	1905	0.32	0.04	90	27.43	293	25.91	0.32
95	603988	4594712	1905	0.08	0.01	90	27.43	293	25.91	0.15
96	603943	4594733	1905	0.16	0.02	82	25.00	293	21.94	0.25
97	603942	4594735	1905	0.10	0.01	82	25.00	293	21.94	0.20
98	603942	4594737	1905	0.40	0.05	82	25.00	293	17.07	0.46
99	603663	4595000	1900	3.24	0.41	125	38.10	293	15.24	1.37
Modified Source #17 and New Source #100										
17	603687	4594807	1902	41.1	5.18	180	54.86	477.6	29.15	3.66
100	603681	4594817	1902	0.2	0.02	126	38.4	293	19.4	0.3

Table 5.3: Modeled Stack Parameters (continued)

Emission Point ID	UTM X (m)	UTM Y (m)	Base Elevation (m)	PM_{10} Emission Rate (lb/hr)	PM_{10} Emission Rate (g/s)	Stack Height (ft)	Stack Height (m)	Exit Temperature (°K)	Exit Velocity (m/s)	Exit Diameter (m)
Nearby Sources FMC-Westvaco										
BC1	599153	4608435	1896	3.01	0.38	93	28.35	350	18.63	0.76
BC2	599153	4608484	1896	1.67	0.21	91	27.74	313	10.35	0.76
MONO11	599323	4607941	1896	3.01	0.38	25	7.62	291	20.70	0.76
MONO12	599331	4608374	1896	1.74	0.22	60	18.29	294	17.25	0.91
MW3	599058	4608059	1896	0.24	0.03	130	39.62	339	18.38	1.98
RA29	598812	4608511	1896	0.32	0.04	80	24.38	355	29.51	1.22
General Chemical										
FD617	603742	4605237	1902	0.24	0.03	4	1.22	286	26.73	0.20
GR3Q	603476	4605127	1902	1.51	0.19	118	35.96	341	13.44	0.91

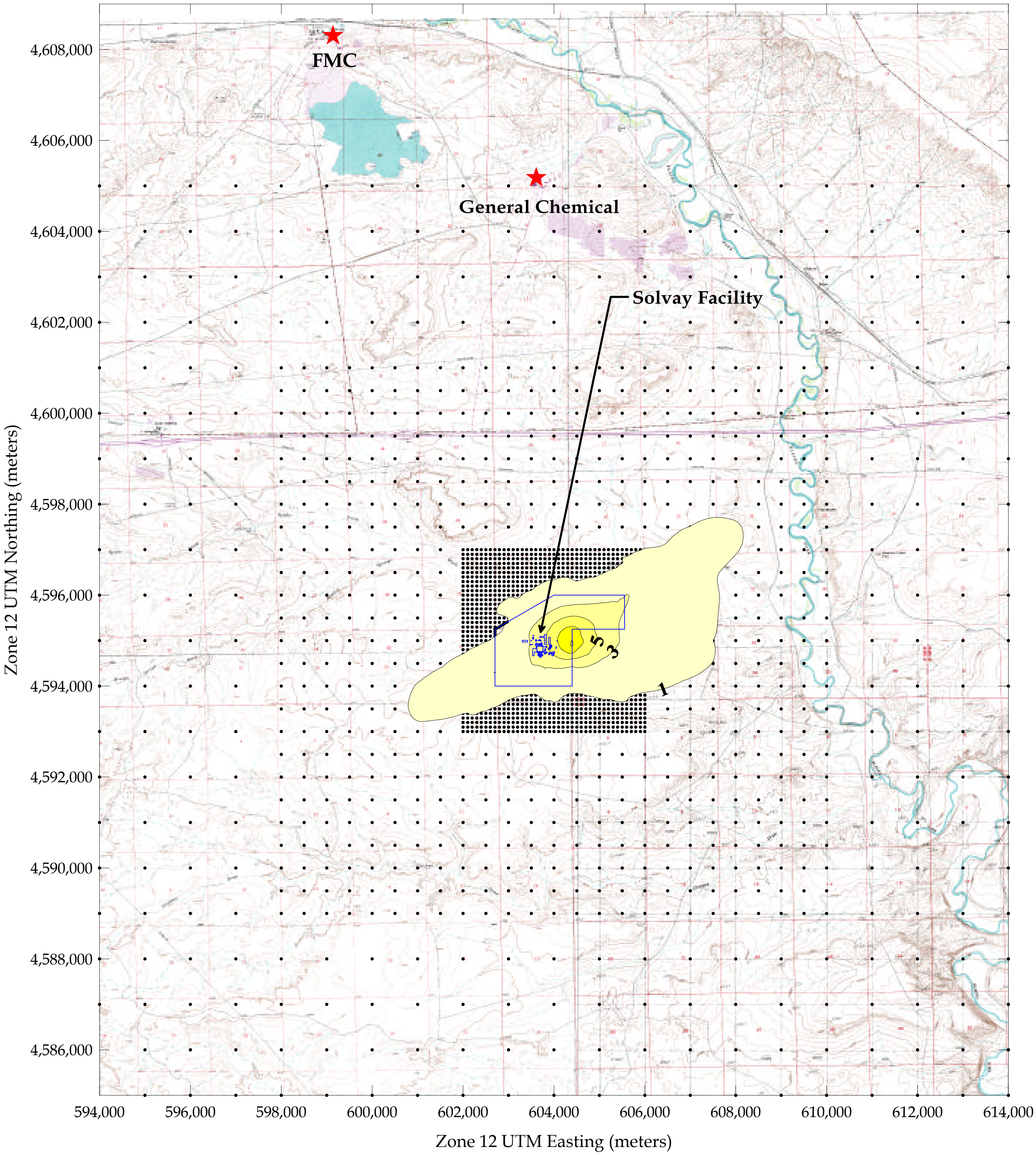
Table 5.4 shows the modeled maximum annual and the 24-hour highest second-highest (H2H) (on an annual basis from the five years of analysis) PM_{10} concentrations as a result of Solvay and the nearby sources' increment-consuming emissions. The maximum impacts occur on the property line directly to the east of the plant. Both the maximum annual (9.3 $\mu g/m^3$) and H2H 24-hour (29.1 $\mu g/m^3$) concentrations are less than the applicable Class II PSD increments.

Table 5.4: Maximum Predicted PM_{10} Impacts Compared With PSD Increments

Averaging Time	Maximum Predicted Impacts ($\mu g/m^3$)	Date	Receptor Location Easting (m)	Receptor Location Northing (m)	Class II PSD Increment ($\mu g/m^3$)
24-hour H2H	29.1	12/26/87	604,400	4,594,850	30
Maximum annual	9.3	1988	604,400	4,594,950	17

Figures 5.2 and 5.3 show the contours of the maximum annual and 24-hour concentrations around the facility. The locations of the two nearby facilities and the receptor grids used in this analysis are also presented. These figures show that the highest impacts are on the property line east of the facility and decrease with distance from the facility.

Figure 5.2: Maximum Annual PM_{10} Impacts



Contour Units in μg/m³

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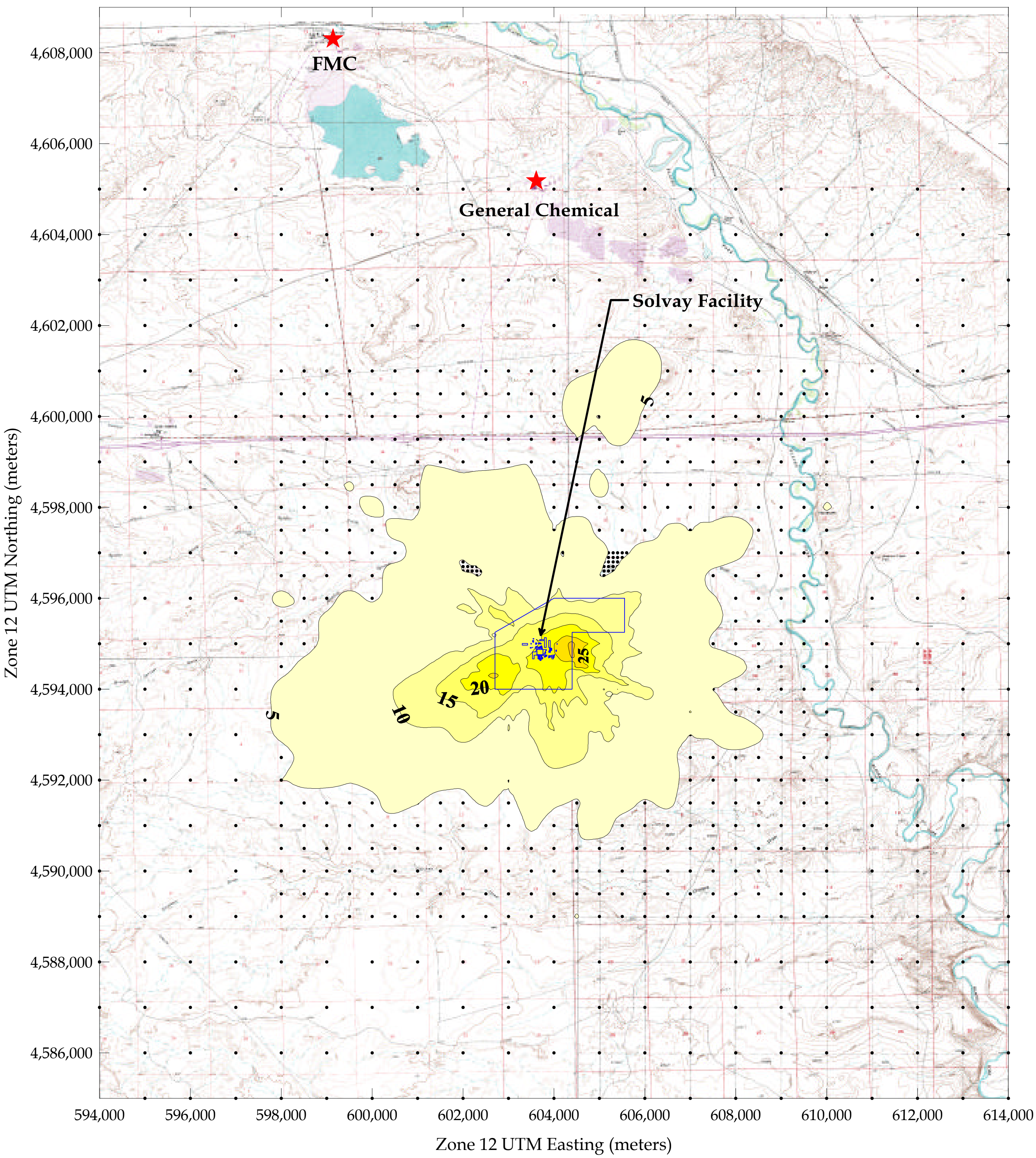
Figure 5.3: Maximum 24-Hour PM_{10} Impacts



Contour Units in μg/m³

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5.4 Toxic Air Pollutants Impact and Risk Assessment

An ambient impact assessment was performed to assess chronic human health impacts and cancer risks associated with hazardous air pollutants (HAP) released from Source #17. (Source #100 HAP emissions are negligible and therefore not considered.) Emission rates for a list of HAPs were estimated using the AP-42 emission factors (Tables 1.1-14 and 1.1-18). These HAPs were selected on the basis of their toxicity and known adverse human health effects. The selected HAPs, their EPA toxicity classification, theAP-42 emission factors, and the estimated emission rates are provided in Table 5.5. These emission factors are representative of the effluent downstream of boilers utilizing an Electrostatic Precipitator (ESP), which are assumed to be similar to the effluent downstream of the ESP on the Solvay furnace.

Table 5.5: Hazardous Air Pollutants Emissions and EPA Classification

HAP	EPA Classification	AP-42 Emission Factor (lb/ton – coal)	Estimated Emission (lb/hr)[a]	Estimated Emission (g/sec)
Arsenic	Group A – Human Carcinogen	4.1×10^{-4}	8.1×10^{-3}	1.0×10^{-3}
Benzene	Group A – Human Carcinogen	1.3×10^{-3}	2.6×10^{-2}	3.2×10^{-3}
Beryllium	Group B – Probable Human Carcinogen	2.1×10^{-5}	4.1×10^{-4}	5.2×10^{-5}
Ethylbenzene	Group D – Not Classifiable as to Human Carcinogenicity	9.4×10^{-5}	1.9×10^{-3}	2.3×10^{-4}
Formaldehyde	Group B1 – Probable Human Carcinogen	2.4×10^{-4}	4.7×10^{-3}	6.0×10^{-4}
Hexane	Group D – Not Classifiable as to Human Carcinogenicity	6.7×10^{-5}	1.3×10^{-3}	1.7×10^{-4}
Mercury	Group D – Not Classifiable as to Human Carcinogenicity	8.3×10^{-5}	1.6×10^{-3}	2.1×10^{-4}
Toluene	Group D – Not Classifiable as to Human Carcinogenicity	2.4×10^{-4}	4.7×10^{-3}	6.0×10^{-4}
Xylenes	Group D – Not Classifiable as to Human Carcinogenicity	3.7×10^{-5}	7.3×10^{-4}	9.2×10^{-5}

[a] Based on a coal consumption rate of 19.7 ton/hr.

The maximum annual impact for each of the above HAPs was estimated using the ratio of maximum annual NO_x impact (µg/m^3) to NO_x emission rate (g/sec) as follows:

where:

C_{Ti} is concentration for toxin i (µg/m^3)

C_{NOx} is NO_x concentration (µg/m^3)

Q_{Ti} is emission rate for toxin i (g/sec)

Q_{NOx} is NO_x emission rate (g/sec)

The estimated maximum TAP impacts were compared with their respective chronic effect thresholds. In the case of known or probable carcinogens, where the cancer risk factors are available, the estimated maximum impacts were divided by their respective one-in-a-million risk factors to estimate the cancer risks associated with the HAP emissions based on a lifetime exposure. The impacts and the applicable chronic exposure thresholds and cancer risks are provided in Table 5.6. This table also lists the sources of the chronic exposure thresholds and cancer risk factors. Detailed calculations are provided in Appendix C on Sheet C.3.

As shown in Table 5.6, the estimated impacts were below the respective chronic effect thresholds for all of the listed HAPs. Therefore, none of these HAP releases from Source #17 pose a significant human health threat. Table 5.6 also shows that all of the estimated cancer risks are below the EPA acceptable one-in-a-million risk. Furthermore, the cumulative risk from Table 5.6 is 1.6 x 10^{-7}, which is also less than the EPA acceptable risk level.

Table 5.6: HAP Impacts, Chronic Exposure Thresholds, and Cancer Risk Factors

TAP	Estimated Maximum Impact ($\mu g/m^3$)	Chronic Exposure Threshold [c, d, e] ($\mu g/m^3$)	One-in-a-Million Cancer Risk Factor [b] ($\mu g/m^3$)	Source	Cancer Risk	Chronic Exposure Exceeded (Yes/No)
Arsenic	3.0×10^{-5}	5.0×10^{-2}	2.0×10^{-4}	IRIS	1.5×10^{-7}	No
Benzene	9.6×10^{-5}	60.0	0.13 to 0.45	CalEPA	7.4×10^{-10}	No
Beryllium	1.6×10^{-6}	2.0×10^{-2}	4.0×10^{-4}	IRIS	3.9×10^{-9}	No
Ethylbenzene	7.0×10^{-6}	1000.0	Not Available	IRIS	N/A	No
Formaldehyde	1.8×10^{-5}	4.0	8.0×10^{-2}	ATSDR	2.2×10^{-10}	No
Hexane	5.0×10^{-6}	200.0	Not Available	IRIS	N/A	No
Mercury	6.1×10^{-6}	3.0×10^{-1}	Not Available	IRIS	N/A	No
Toluene	1.8×10^{-5}	400.0	Not Available	IRIS	N/A	No
Xylenes	2.7×10^{-6}	400.0	Not Available	ATSDR	N/A	No

[b] EPA Air Toxics Website (http://www.epa.gov/ttn/atw/hapindex.html) and IRIS.
[c] EPA Integrated Risk Information System (IRIS), Reference Concentration (RfC).
[d] California EPA (CalEPA), Chronic Reference Exposure Level.
[e] Agency for Toxic Substances and Disease Registry (ATSDR) , Chronic Inhalation Minimal Risk Level (MRL).

SECTION 6

CLASS I MODELING

6.1 Impact Thresholds

The Wyoming Chapter 6 Permitting Requirements, Section 2(c)(iii), require that the impacts of any proposed facility not cause an exceedance of the Class I area increments. These increments are provided in Table 6.1. Moreover, the EPA has proposed (FR July 23, 1996, pp. 38,249 – 38,344) to allow for a demonstration of "insignificant impact," which exempts a proposed facility from performing a full increment consumption analysis (WY DEQ follows this procedure.) The levels of "insignificant impact" for NO_x and PM_{10} are also provided in Table 6.1.

Table 6.1: Proposed Class I Area PSD Increments and Modeling Significance Concentrations

Pollutant	Increment ($\mu g/m^3$)	Significance ($\mu g/m^3$)
NO_x - annual average	2.5	0.1
PM_{10} - annual average	4.0	0.2
PM_{10} - 24-hour maximum	8.0	0.3

The USDA Forest Service has proposed a concern threshold for visual range and acid neutralization capacity of high elevation lakes (http://www.fs.fed.us/r6/aq/ natarm/r4/ bridger_ct.htm). The impacts from the proposed Solvay Source #17 modification were compared with an impact threshold of 5 percent of background extinction ($ß_{ext}$) for the individual source.

The second AQRV is acid deposition to surface waters. The threshold for "potential to impact" for acid deposition to wilderness lakes is the larger of the following:

- a relative change of 10 percent in ANC (eq) relative to baseline, and
- an absolute change in lake alkalinity of 1 μeq/l.

The following Class I Area impact analysis is performed according to the November 2002 "Class I Area Impact Analysis Protocol" modified by the February 10, 2003 Wyoming DEQ comments on that protocol. Analysis detail presented in those documents will not be repeated herein.

6.2 AQRV Baselines

6.2.1 Visual Range Natural Background

The AQRV impact analyses incorporate baseline values. The visual range analysis was based on measured values representative of "natural background" in the Class I areas. The measured constituent data for Bridger is provided in Table 6.2.

Table 6.2: Summary of Measured Background Visual Range Parameters at the Bridger/Fitzpatrick IMPROVE Monitoring Site, 1988-1999

Season	Dry Hygroscopic (Mm^{-1})	Non-Hygroscopic (Mm^{-1})
Winter	0.81	1.96
Spring	1.99	3.41
Summer	1.91	6.10
Fall	1.40	3.60

The measured background VR values in Table 6.2 were calculated as follows. The data from 1988 to 2001 for the IMPROVE site at Bridger (BRID1) were obtained from the IMPROVE website. Only data up to 1999 were included in the analysis, since the 2000 and 2001 data had not undergone the highest level of quality control. Background levels were calculated for non-hygroscopic and hygroscopic compounds separately. Non-hygroscopic compounds include coarse particulate matter (PM_{10}-$PM_{2.5}$), elemental carbon, organic carbon, and soil particles. The hygroscopic compounds include ammonium nitrate and ammonium sulfate (IWAQM2, 1998). Summaries were based on the seasons (FLAG, 2000), specifically, winter (December, January, February), spring (March, April, May), summer (June, July, August), and fall (September, October, November). For each year-by-season combination the 20th-percentile value was calculated for the non-hygroscopic- and (dry) hygroscopic extinction values (units of Mm^{-1}). The background extinctions from 1988-1999 were calculated as the mean of the 20th-percentile values for each season. Only seasons with more than 50 percent of the data present were used in the analysis (Watson, 2002). Based on this criterion the winter season in 1988 was excluded from the analysis.

6.2.2 Lake Acid Neutralization Capacity Baseline

Two parameters needed to be estimated to establish the baseline acid neutralizing capacity (ANC): baseline lake alkalinity (μeq/l) and estimated annual precipitation (m). Baseline lake alkalinity was calculated as the 10th-percentile lake alkalinity values for six lakes in the region (Forest Service, 2000). Data for the indicator lakes were provided by the USDA Forest Service (FS, 2002) and are shown in Table 6.3. The lake elevations varied from 2950 to 3432 m asl. The FS data set consisted of a time series of measurements of the baseline alkalinity, including duplicates, the number of which varied from year to year and lake to lake. The 10th-percentile values were calculated from the entire data set, covering up to an 18-year record (Table 6.3). Blanks and negative values were excluded from the calculation. Note that Upper Frozen Lake was recently added to the set of "indicator lakes." Data collection began in 1997, and to date there have been four samplings: one day per year in July or August for 1997, 1999, 2000, and 2001. For two of the samplings, a duplicate was also collected, making a total of six available readings with a range of 11.4 μeq/l as the highest to 1.3 μeq/l as the lowest. From this extremely small data set, the 10th-percentile most sensitive ANC value is 2.0, which is very low.

Table 6.3: Baseline ANC for Indicator Lakes

Lake	Period of Records	Number of Observations	10th-Percentile Most Sensitive Lake Alkalinities (μeq/l)
Black Joe	1984 –2001	186	60.0
Deep	1984 –2001	172	60.1
Hobbs	1984 –2001	197	70.3
Ross	1985 –2001	140	55.7
Lower Saddlebag	1986 –2001	147	55.8
Upper Frozen	1997 –2001	6	2.0

The second estimated parameter needed to calculate baseline ANC is the annual precipitation at the lakes under consideration (FS, 2000). The annual precipitation at the high elevation lakes in the Class I areas was estimated as the 16-year average precipitation (period 1986 to 2001) based on data from two NADP deposition stations, Gypsum Creek (WY98) and Pinedale (WY06). The Pinedale site is located approximately 20 km south from the site used to monitor visibility in the Bridger Wilderness Area (IMPROVE site BRID1) and approximately 40 km from the western border of the Bridger Wilderness Area. The Gypsum Creek site is located within 5 km of the Bridger Wilderness Area, and ~ 30 km north of Pinedale. Both sites are located at approximately 2,400 m ASL. The estimated annual precipitation at these sites were 37 and 29 cm per year (~14.6" and 11.4"), for Gypsum Creek and Pinedale, respectively. To yield the more conservative estimate of the change in ANC, the higher precipitation rate at Gypsum Creek was used in the analysis.

6.3 Dispersion Analysis Approach

6.3.1 Model Selection

Because the Class I areas are more than 50 km from the Solvay facility, long-range transport was applicable. The Interagency Workgroup on Air Quality Modeling Phase 2 Summary Report and Recommendations for Modeling Long-Range Transport Impacts (IWAQM2), Federal Land Managers Air Quality Related Values Work Group Phase I report (FLAG, 2000), recommends the use of the CALPUFF modeling system (Version 5.4) for evaluating impacts on a regional scale. CALPUFF is a multi-layer, gridded, non-steady-state lagrangian puff dispersion model that can simulate the effects of temporally and spatially varying meteorological conditions on pollutant transport and dispersion.

At DEQ's request, the Southwest Wyoming Technical Air Forum (SWWYTAF) 1995 CALPUFF analysis (February 2001) was used as the basis for this analysis. The objective of the SWWYTAF study was to evaluate the degree of degradation of air quality, visibility, and other AQRVs in the Fitzpatrick and Bridger Class I areas caused by all upwind sources (natural and anthropogenic), and to evaluate the performance of the non-steady-state CALPUFF dispersion model and its associated wind field model CALMET in predicting the measured air quality and AQRVs during 1995 in the Class I areas. Details of the SWWYTAF study are summarized below, with emphasis on proposed changes from the SWWYTAF approach.

6.3.2 Geophysical Data

The modeling domain and geophysical data from the SWWYTAF study was used. The SWWYTAF modeling domain included the southwestern portion of Wyoming, northeastern Utah, southeastern Idaho, and northwestern Colorado, and consisted of 116 by 100 grid cells at a 4-km spacing, which corresponded to a domain of 464 km in X by 400 km in Y. The southwest corner had the coordinates of -335.0 in X and -258.0 in Y. The coordinate system is a Lambert Conic Conformal (LCC) coordinate system with standard latitudes of 30 and 60 degrees, reference latitude of 42.55 degrees, and reference longitude of 108.55 degrees. The SWWYTAF terrain data were extracted from a 1-degree Digital Elevation Model (DEM), which has an approximate grid spacing of 90 meters. The land use data were extracted from the USGS composite theme grid (CTG) 1:250,000 (1 degree) scale files. These data were processed for the SWWYTAF study and were contained in the GEOSWY.DAT file. A surface map of the CALMET and CALPUFF modeling domain is given in Figure 6.1.

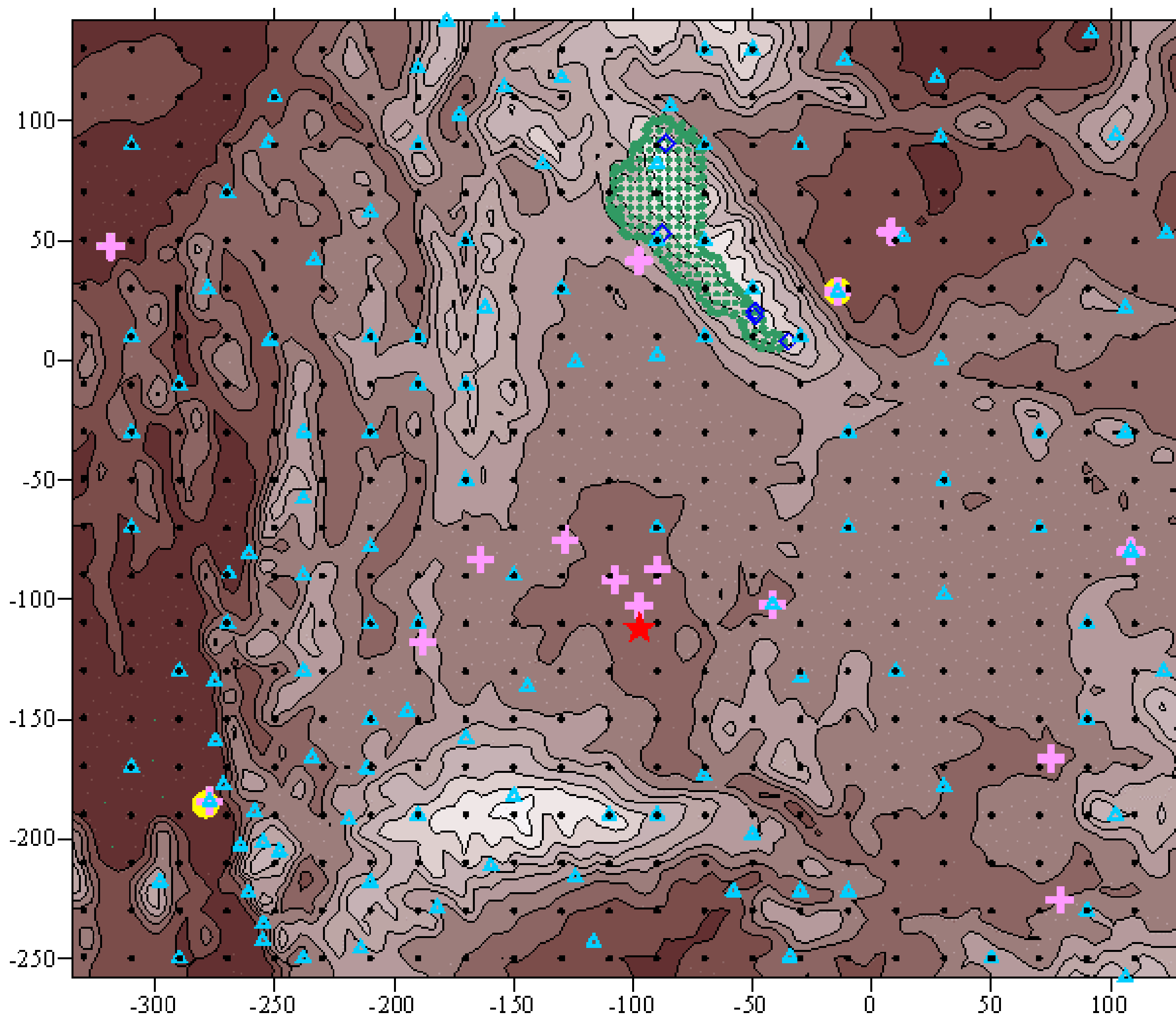
6.3.3 Meteorological Data

The meteorological data were processed using CALMET. A sample CALMET input file is provided on the CD accompanying this report. In the SWWYTAF study, the time-varying large-scale wind flow was derived using a combination of the coarse-grid (20 km) MM5 simulations, direct surface observations, and vertical soundings. Figure 6.1 shows the locations of the meteorological input data.

The MM5 data were generated by the National Center for Atmospheric Research (NCAR) using the PSU/NCAR Mesoscale Model System, Version II. The data have 11 standard levels (surface, 1000, 850, 700, 500, 400, 300, 250, 200, 150, and 100 hPa) and include two-dimensional snow cover, the sea surface temperature, the sea level pressure, and three-dimensional variables of temperature, geo-potential height, U and V components of wind, and RH.

In addition to the MM5 data, CALMET requires hourly surface observations of wind speed, wind direction, temperature, cloud cover, ceiling height, surface pressure, relative humidity, and precipitation type (e.g., snow, rain). For SWWYTAF, a total of 22 surface stations were used (Table 6.4). Hourly observations from these stations were processed for SWWYTAF and were used in this analysis.

Figure 6.1: CALMET and CALPUFF Modeling Domain



Legend:

Description	Symbol
Terrain	Base; lighter colors indicate increasing elevation
Source location	Red star
MM5 data grid	Black circles
Surface stations	Pink crosses
Upper air stations	Yellow circles
Precipitation stations	Light blue triangles
Class I area receptors	Green circles
High elevation lakes	Dark blue diamonds

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Table 6.4: Surface Meteorological Data Stations Used in the SWWYTAF Analysis

Surface Station	Source
Casper, WY	NWS
Cheyenne, WY	NWS
Denver, CO	NWS
Lander, WY	NWS
Grand Junction, CO	NWS
Pocatello, ID	NWS
Rock Springs, WY	NWS
Salt Lake City, UT	NWS
Rawlins, WY	FAA
Riverton, WY	FAA
Baggs, WY	Mt. Zirkel Study
Craig, CO	Mt. Zirkel Study
TG Soda Ash	Industrial Site
OCI	Industrial Site
Naughton	Industrial Site
General Chemical	Industrial Site
Amoco	Industrial Site
Exxon	Industrial Site
Pinedale	NDDN
Centennial	NDDN
Yellowstone NP	NPS
Craters of the Moon NP	NPS

CALMET also requires twice-daily observations of the vertical profiles of wind speed, wind direction, temperature, and pressure. For SWWYTAF, there were four sites observed for upper air data (Table 6.5). The data from these sites were processed for SWWYTAF and were used in this analysis.

Table 6.5: Upper Air Meteorological Data Stations Used in the SWWYTAF Analysis

Upper Air Station	Source
Denver, CO	Twice-daily upper air (TD6201) soundings (NWS)
Grand Junction, CO	Twice-daily upper air (TD6201) soundings (NWS)
Lander, WY	Twice-daily upper air (TD6201) soundings (NWS)
Salt Lake City, UT	Twice-daily upper air (TD6201) soundings (NWS)

In order to calculate wet deposition rates, CALMET requires hourly precipitation rates across the domain. Generally, most precipitation stations tend to be at lower elevations. However, because the presence of high terrain can substantially enhance the amount of precipitation, the use of only the lower level stations can result in an underestimate of the precipitation in areas of elevated terrain. Therefore, in the SWWYTAF study, additional sources of precipitation data were used to properly characterize the precipitation patterns in the SWWYTAF domain. For SWWYTAF, 4-km resolution PRISM climatological precipitation data were used to convert the 20-km MM5 predictions to a 4-km resolution and to produce a more representative terrain-induced spatial pattern. Likewise, the observed hourly precipitation data were scaled by the PRISM annual values for consistency. The scaled MM5 data were combined with the scaled hourly precipitation observations to produce the final precipitation field. This scaled SWWYTAF precipitation file was used in this analysis.

6.3.4 Wind Field Generation

The time-varying wind fields were generated using the CALMET program and the SWWYTAF geophysical data file (GEOSY.DAT), MM5 data, surface data file (with RH pseudo stations added), upper air data files, and scaled precipitation data. CALMET was run using the model settings as used in SWWYTAF.

6.3.5 CALPUFF Settings and Execution

Once the CALMET wind fields were completed, the CALPUFF model was run to calculate concentrations, and wet and dry deposition rates of all relevant pollutants. For this analysis, the RIVAD/AM3 chemistry was used, which included SO_2, SO_4, NO, NO_2, HNO_3, NO_3, and fine particulate species. The particulate emissions from the proposed source were modeled as PM_{10}.

The Class I area receptors from the SWWYTAF study were used. These receptors were placed every 2 kilometers along the boundary of each Class I area and on a 4-km resolution grid within each Class I area.

Building downwash parameters, as estimated by the Building Profile Input Program (BPIP Version 95086), were be incorporated into the CALPUFF analysis.

Hourly ozone data from the SWWYTAF study were used. This data includes ozone measurements from six stations: Pinedale, WY; Centennial, WY; Yellowstone NP, WY; Craters of the Moon NP, ID; Highlands, UT; and Hayden, CO. Missing data hours were set to an ozone concentration of 44.7 ppb, in accordance with SWWYTAF.

CALPUFF requires a domain average ambient ammonia (NH_3) concentration. The IWAQM2 recommended value of 1 ppb, representative of arid climates, was used in the model runs. Given the arid nature of the land and the low NH_3 emission fluxes (< 1 ton/sq. mile/yr) in the modeling domain, the 1 ppb value was reasonable for this application. (See NH_3 emissions density map from EPA's National Air Pollution Emissions Trends Update, 1970-1997 [1998]; http://www.epa.gov/ttn/chief/trends/trends98/.) Furthermore, this value was corroborated by a SWWYTAF impact estimate of 1.1 ppb region-wide, performed as an ancillary modeling exercise and based upon a region-wide NH_3 emission rate of approximately 0.23 ton/sq. mi/year.

The CALPUFF module was run using the proposed potential emissions (Table 2.3, Column #5) to calculate pollutant concentrations, and wet and dry deposition rates at each receptor in the Class I areas. Emissions from both Source #17, the calciners, and from Source #100, a small baghouse, were included in the model runs. The latter source only had PM_{10} emissions, which were one two-hundredth of those from Source #17.

The CALPUFF input file has been provided with this report on the accompanying CD.

6.4 PSD Increment Consumption

6.4.1 Methods

The annual average NO_2 and NO concentrations for all Class I area receptors were extracted from the model output using the CALPOST module. For each receptor these NO_2 and NO concentrations were added to obtain the annual NO_X concentration by receptor. The highest annual NO_X concentration was extracted from all receptors and compared to the significant impact level (SIL, Table 6.1). Similarly, the maximum 24-hour PM_{10} concentration and the annual average PM_{10} concentration were extracted from the CALPUFF output using CALPOST. The highest PM_{10} concentration for each averaging period was extracted from all receptors and compared to the SILs (Table 6.1).

Results of the NO_x and PM_{10} incremental impacts (the ground level concentrations) were compared with the allowable PSD increments listed in Section 6.1. If the proposed emissions from Source #17 (and Source #100) triggered "significance" (Section 6.1), a cumulative increment analysis would be needed, and all domain increment-consuming emissions (as described in 5. 1) would need to be modeled.

6.4.2 Results

The results from the Class I significant impact threshold comparison analysis are shown in Table 6.6. The highest predicted concentrations in the Bridger and Fitzpatrick Wilderness Areas were well below the SILs. Therefore a full-scale cumulative increment analysis is not needed.

Table 6.6: CALPUFF Class I Area Impact Comparison with Significant Impact Level

Pollutant and Averaging Period	Receptor Number	Maximum Predicted Impact ($\mu g\ m^{-3}$)	PSD Class I Increment ($\mu g\ m^{-3}$)	Class I SIL ($\mu g\ m^{-3}$)
NO_X - Annual	197	0.0051*	2.5	0.1
PM_{10} – Annual	182	0.0011	4.0	0.2
PM_{10} – 24-hours	197	0.0504	8.0	0.3

* NO_X prediction consisting of 0.0048 and 0.0003 $\mu g\ m^{-3}$ from NO_2 and NO, respectively.

6.5 Visual Range

6.5.1 Methods

The CALPOST processor was used with the concentrations and the background f(RH) values to calculate the light extinction (visibility impairment) in the Class I areas. For this analysis, monthly background f(RH) values were used, as shown in Table 6.7. These f(RH) values were based on the *Draft Guidance for Tracking Progress Under the Regional Haze Rule* , Appendix A (EPA, September 2001) for each Class I area. Since the f(RH) values for the Bridger- and Fitzpatrick Wilderness Areas (Table 6.7) are similar, the higher of the two monthly f(RH) values were used for both Class I areas.

Table 6.7: Monthly Site-Specific f(RH) Values at the Bridger - and Fitzpatrick Class I Areas

Month	Bridger	Fitzpatrick	Month	Bridger	Fitzpatrick
January	2.52	2.51	July	1.50	1.51
February	2.35	2.33	August	1.49	1.46
March	2.34	2.24	September	1.74	1.73
April	2.19	2.13	October	2.00	1.98
May	2.10	2.09	November	2.44	2.39
June	1.80	1.80	December	2.42	2.44

The results were compared with the thresholds described in Section 6.2.1.

6.5.2 Results

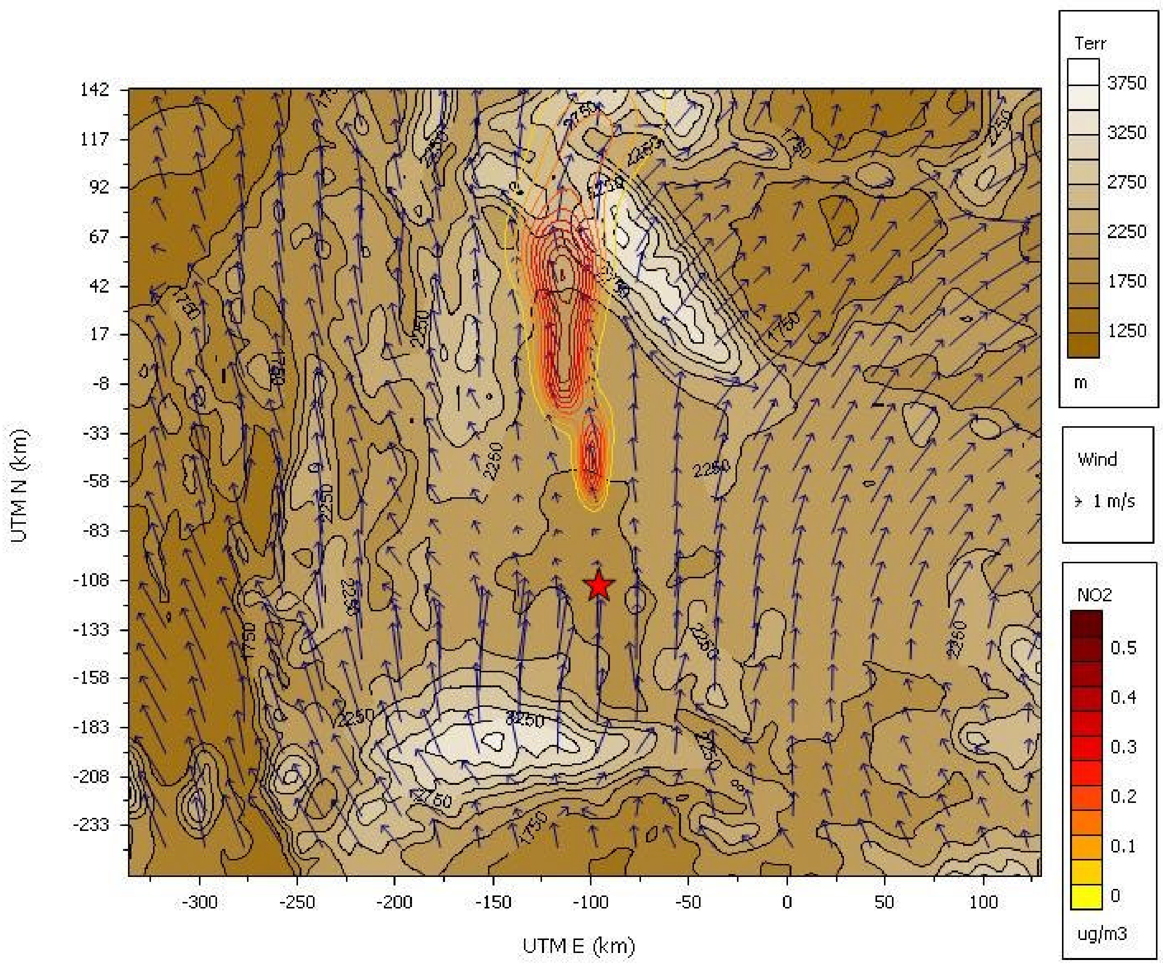
The visual range analysis results are summarized in Table 6.8. The highest change in extinction (B_{ext}) was 1.65 percent. This day of the highest visibility impact occurred on a day with winds predominantly from the south that transported the emissions to the Class I area during most of the day (Figure 6.2). The visual range analysis also showed that nitrate is the main contributor to the visibility impacts, accounting for 87 to 99 percent of the change in extinction (Table 6.8).

Overall, the visual range analysis indicated that the 5 percent concern threshold for visibility in the Class I areas would not be exceeded based on the highest potential emissions from the proposed source.

Table 6.8: Visual Range Analysis Results

Date	Receptor	Bext (1/Mm)			Delta Bext (%)	f (RH)	Bext by Component (%)	
		Model	Background	Total			Bx NO_3	Bx PM_{10}
Jan 25th	173	0.231	14.00	14.232	1.65	2.52	87	13
Dec 16th	195	0.158	13.92	14.078	1.14	2.42	87	13
May 4th	204	0.157	20.13	20.289	0.78	2.10	98	2
May 25th	167	0.081	20.13	20.213	0.40	2.10	99	1
June 11th	138	0.071	19.56	19.627	0.36	1.80	96	4
Threshold					**5.0**			

Figure 6.2: Wind Fields (120 m) and NO_2 Concentration for January 25th, 1995 (12 pm).



6.6 Change in Acid Neutralizing Capacity

6.6.1 Methods

Nitrogen deposition rates were extracted from the CALPUFF output file using the POSTUTIL and CALPOST programs. POSTUTIL takes the CALPUFF wet and dry deposition files with the CALPUFF defined species (i.e., NO_2, HNO_3, $(NH_4)_2SO_4$) and calculates N deposition rates. The N deposition rates in the POSTUTIL output file (g m^{-2} s^{-1}) were calculated using the conversion factors according to the guidelines provided with POSTUTIL:

$$\text{N deposition (g m}^{-2}\text{ s}^{-1}) = 0.304{*}NO_2 + 0.222{*}HNO_3 + 0.452{*}NO_3^{-1} + 0.292{*}SO_4^{-2}$$

Although not shown in the equation above, the nitrogen from background ammonium was also included in the N deposition rate. CALPOST was used to extract N deposition for all receptors. One specific receptor was established for each of the lakes, based on their latitude and longitude, with the exception of Upper Frozen Lake. For this lake geo-referenced coordinates were not available, and the highest nitrogen deposition over all the Class I receptors was used in the ANC change calculation. This provided the most conservative estimate possible. The CALPUFF generated total nitrogen deposition was used in the calculation of the change in ANC, according to the methodology described in *Screening Methodology for Calculating ANC Change to High Elevation Lakes* (US Forest Service, 2000). Annual precipitation was estimated as described in Section 6.2.2. The baseline lake alkalinities are shown in Table 6.3. Results of the calculated change in ANC were compared with the AQRVs in Section 6.1.

6.6.2 Results

Table 6.9 summarizes the estimated change in ANC for each of the six high elevation lakes in the Bridger- and Fitzpatrick Wilderness Areas. The highest predicted change in ANC was found for Upper Frozen Lake, which can be explained by the extremely low baseline alkalinity at this lake (Table 6.3; Table 6.9). However, even at Upper Frozen Lake the predicted change in ANC was considerably below the AQRVs, both expressed on a percent basis and on a concentration basis (μeq l^{-1}). Thus, based on the highest potential emissions from the proposed source the predicted change in ANC did not exceed the threshold for "potential to impact".

Table 6.9: Summary of Estimated Change in ANC for Six High Elevation Lakes

Lake Name	Lake Elevation* (m asl)	Baseline ANC** (equivalents)	H^+ Deposition*** (equivalents)	Change in ANC	
				Percent	$\mu eq\ l^{-1}$
Black Joe	3122	150	0.13	0.09	0.16
Deep	3201	150	0.14	0.09	0.17
Hobbs	3085	176	0.09	0.05	0.11
Ross	2948	139	0.05	0.04	0.06
Lower Saddlebag	3432	139	0.18	0.13	0.22
Upper Frozen	No data	5	0.18	3.58	0.22
Threshold				**10**	**1**

* Estimated elevation based on the terrain file processed by CALMET

** Calculated based on baseline alkalinities provided by US Forest service, Table 6.3

*** Based on CALPUFF output processed by POSTUTIL and CALPOST

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SECTION 7

COMPLIANCE DEMONSTRATION

With this modification, there is to be an add-on control technology for the purpose of minimizing the NO_x emissions. Under the Compliance Assurance Monitoring (CAM) Rule, compliance with the NO_x emission limit (lb/MMBtu) is to be demonstrated on a minimum 15-minute basis. Solvay proposes to provide this demonstration parametrically using measured ammonia injection rate and heat rate. These two variables will be associated with the NO_x emission rate using data from an initial stack test on the two units. This initial stack test will consist of multiple operating point emissions measurements for the purpose of defining the relationship of ammonia injection rate and heat rate to NO_x emissions.

The calciners exhaust, Source #17, already includes a continuous opacity monitor for the continuous tracking of particulate emissions, so it is exempt from the CAM rule (40CFR64.2, (b),(i)).

SECTION 8

REFERENCES

FLAG, *Federal Land Managers' Air Quality Related Values Workshop (FLAG) Phase I Report*, December 2000)

EPA, FR July 23, 1996, pp. 38,249 – 38,344

IWAQM2, EPA-454/R-98-019, 1998

J.G. Watson, Visibility: Science and Regulation, *Air & Waste Management Association,* 2002, 52, pp. 628-713

Forest Service, *Users Guide - Screening Methodology for Calculating ANC Change to High Elevation Lakes,* 2000

Forest Service, Excel data transfer from Terry Svalberg, Forest Service, Pinedale WY, to Rodger Steen, Air Sciences Inc. 9/3/2002

SWWYTAF, Earth Tech, Concord MA, *The Southwest Wyoming Regional CALPUFF Air Quality Modeling Study - Final Report including Project Data Files,* February 2001

Air Sciences Inc., *Northeast Wyoming Emissions Inventory*, for Wyoming DEQ, January 2002

APPENDIX A

Calculations of Emissions

APPENDIX B

BACT Review References

APPENDIX C

Class II Impact Model Results

APPENDIX D

Class I Impact Model Results